An Individual-Based Model to support identification of Critical Habitat for Southern Resident killer whales

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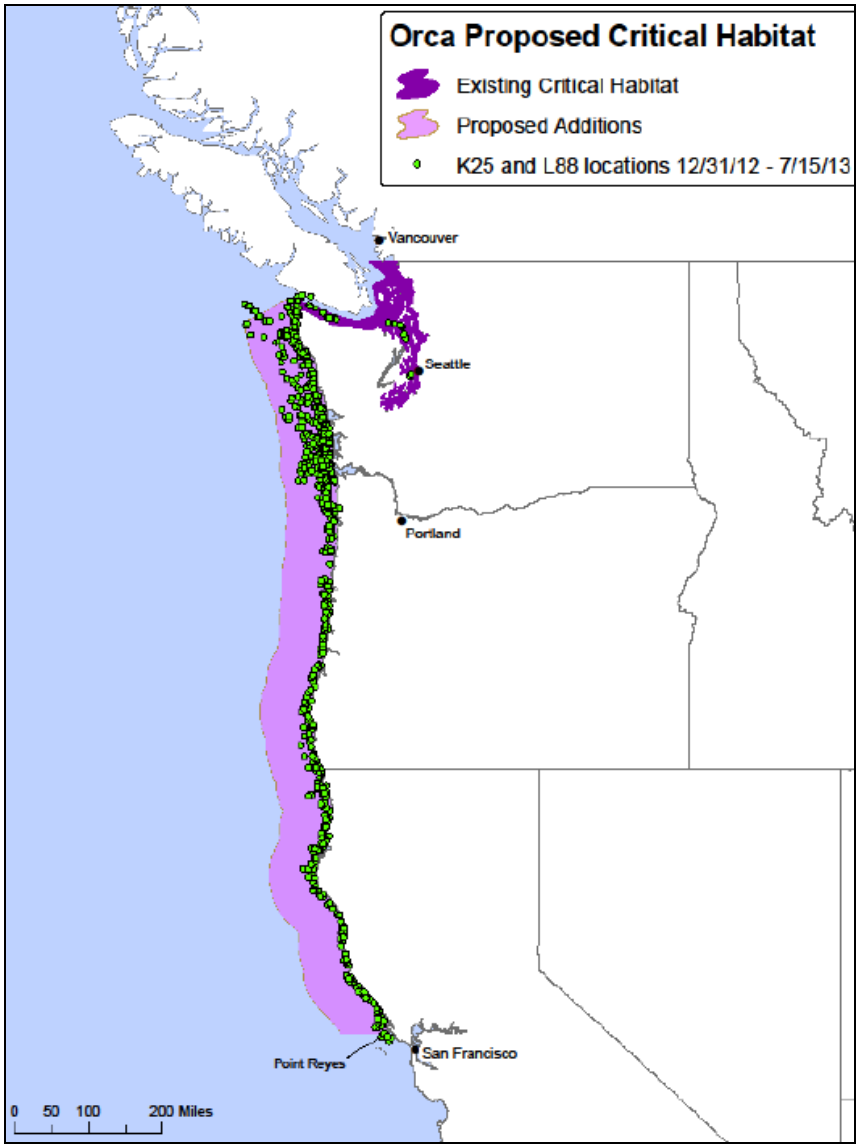
La Jolla CA


Orca Proposed Critical Habitat
Existing Critical Habitat
Proposed Additions
K25 and L88 locations 12/31/12 - 7/15/13
Vancouver
Seattle
Portland
San Francisco
Point Reyes
0 50 100 200 Miles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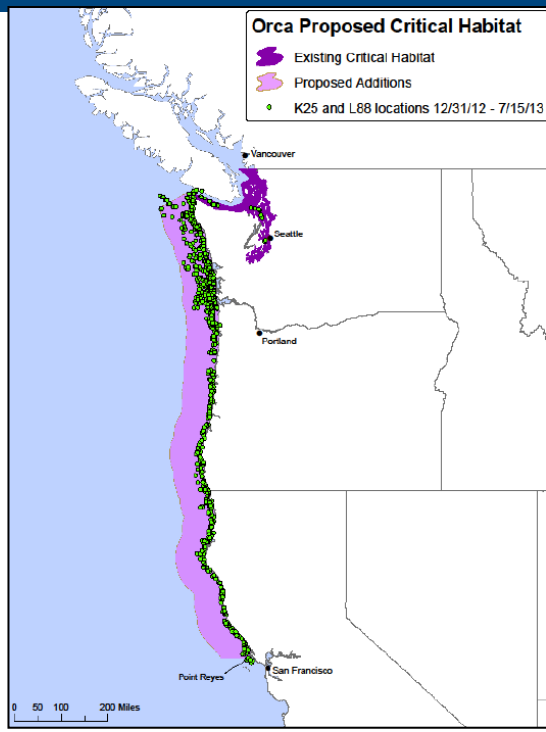
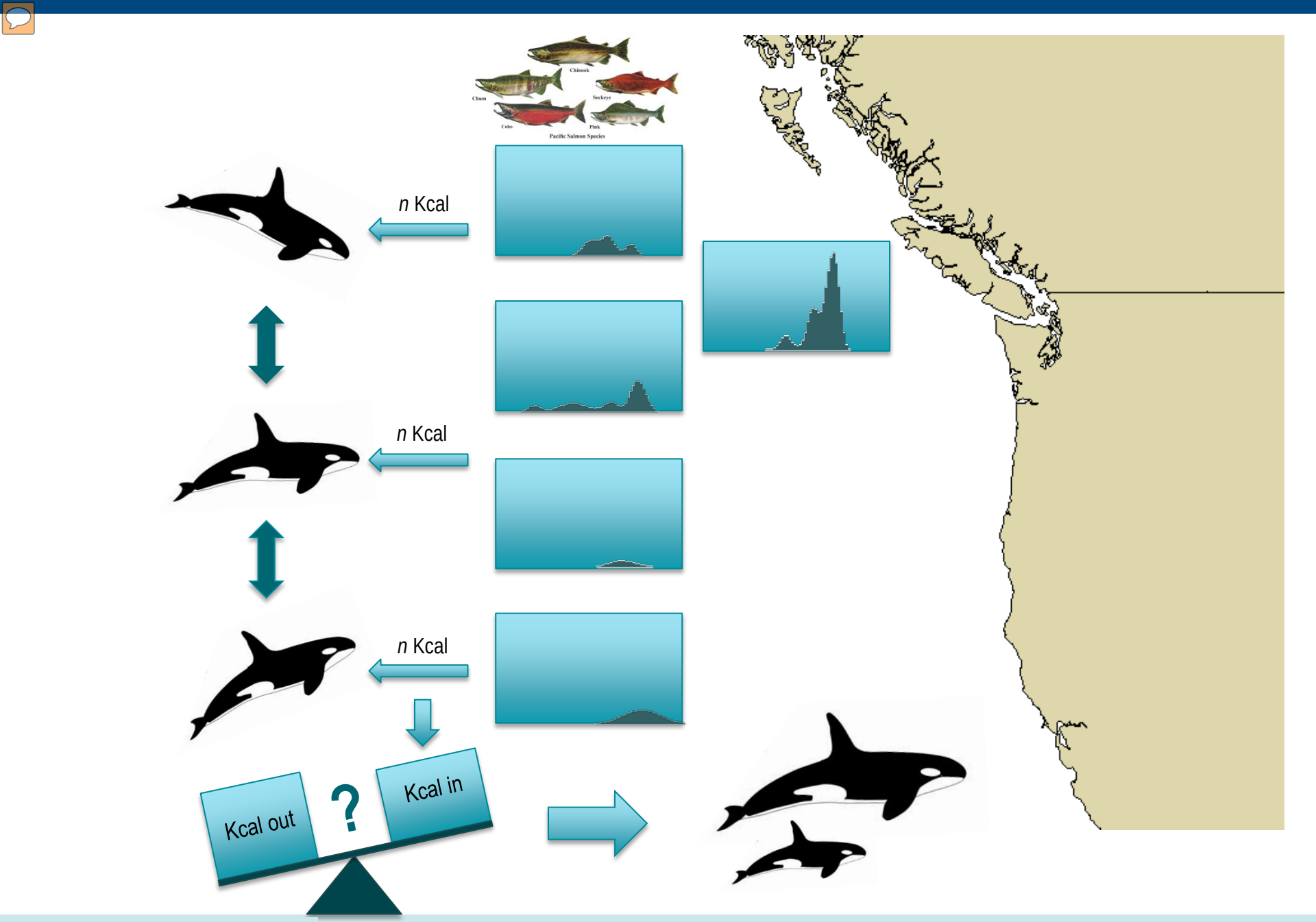
Motivation

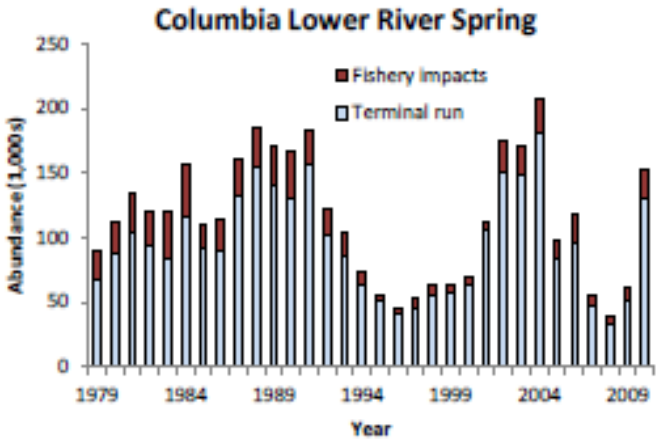
- What can we infer about their year-round distribution patterns, including coastal waters?

- What can we learn about which fish stocks, or groups of fish stocks, are critically important for Southern Resident killer whales?

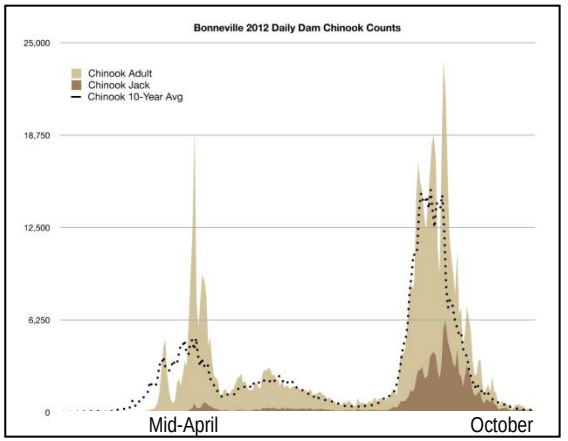



Chinook
Chum
Sockeye
Coho
Pink
Pacific Salmon Species
n Kcal
n Kcal
n Kcal
Kcal out
?
Kcal in

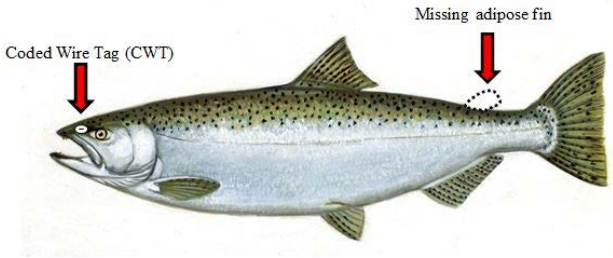
Overview

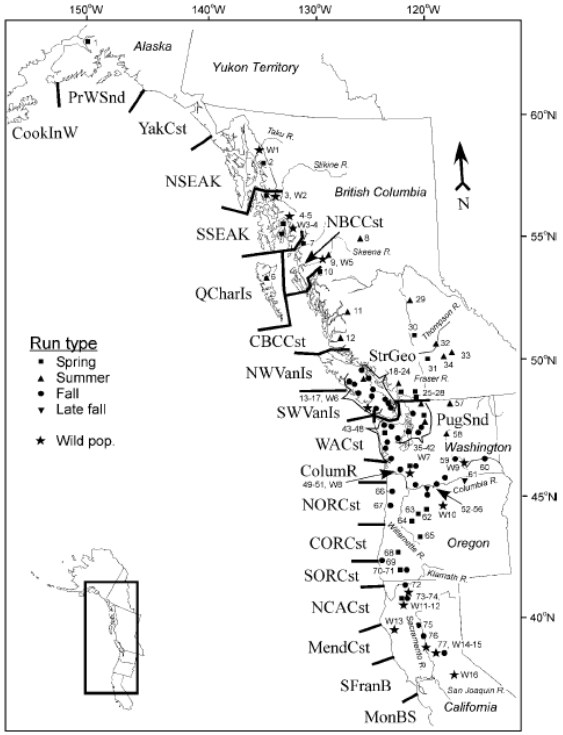


Source: Ward et al. 2013

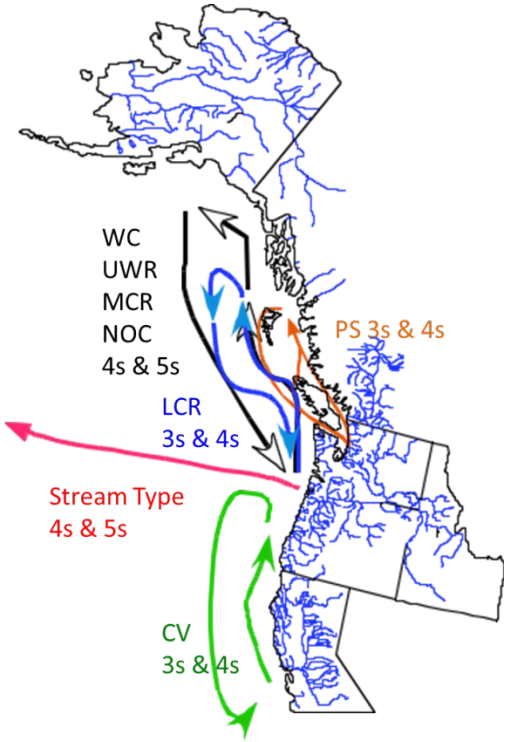


Source: CRITFC



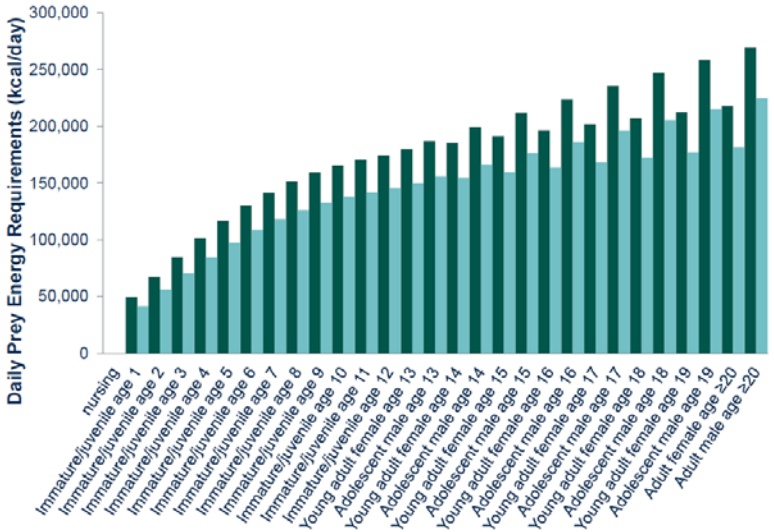


Source: Weitkamp 2010



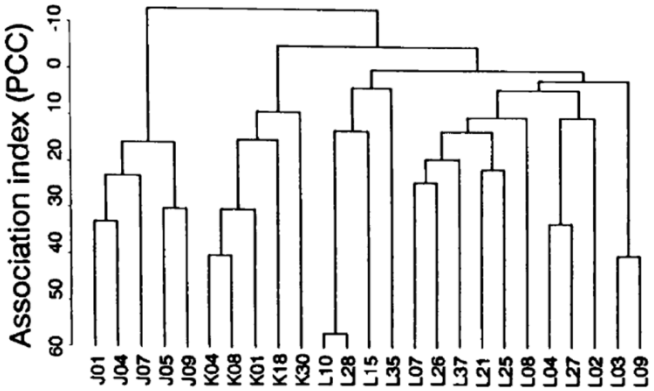
Source: Myers 2012

Prey field

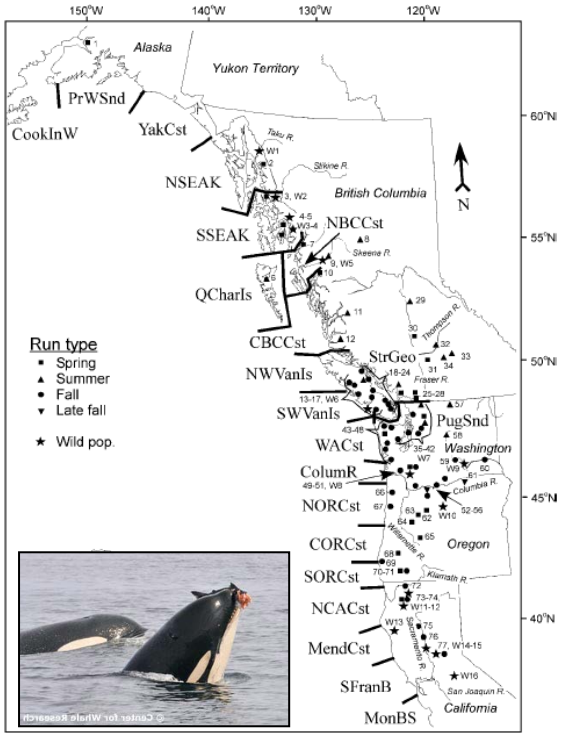


Source: Noren 2011

Individual killer whales



Source: Bigg et al. 1990



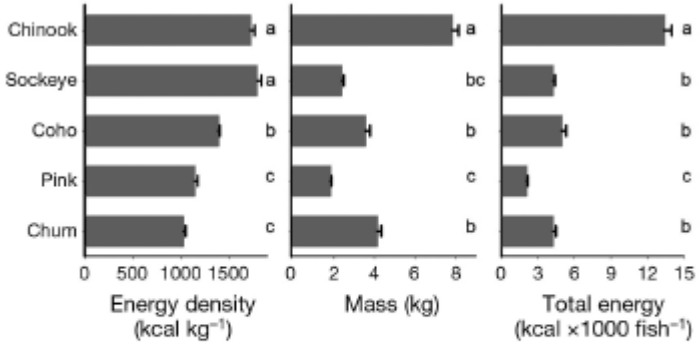
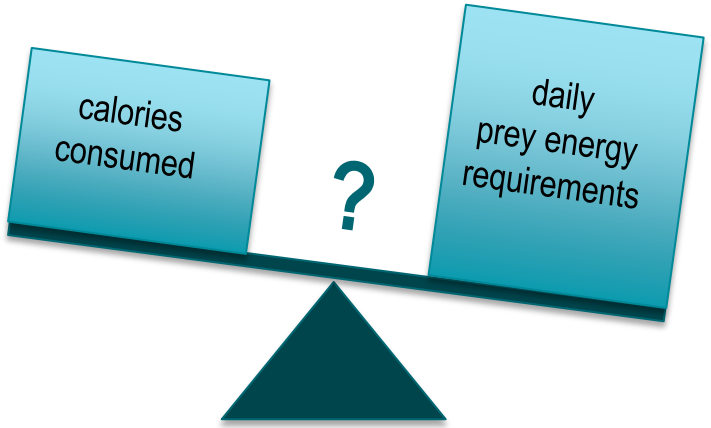


Fig. 2. *Oncorhynchus* spp. Average (±SE) energy density, mass, and total energy of whole-body samples of mature Pacific salmon. Significant differences in energy density, fish mass, and total energy (in kcal) among mature Pacific salmon population-complexes are noted by different letters (a to c). See Table 2 for individual species names

Source: O'Neill et al. 2014



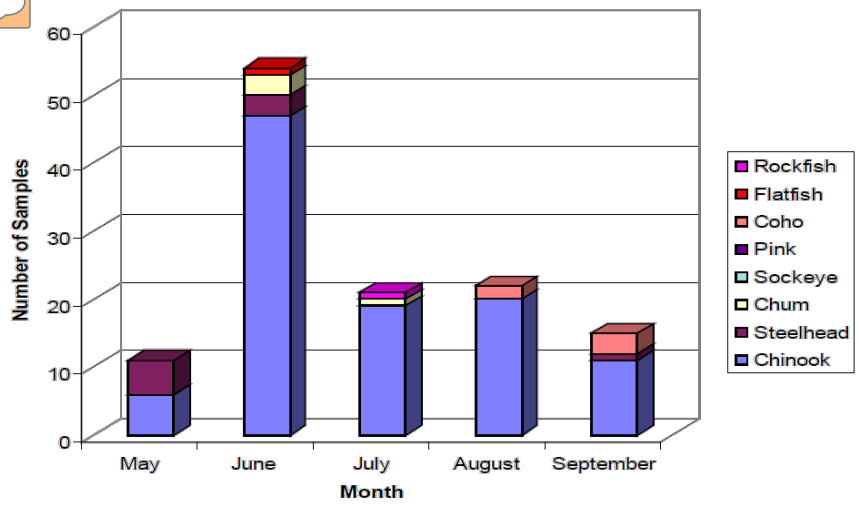
Movement patterns -> prey consumption -> energy balance

Survival model:

$$logit(\varphi_{i,y}) = \beta_{stage(i)} + \beta_1 E_{i,y}$$

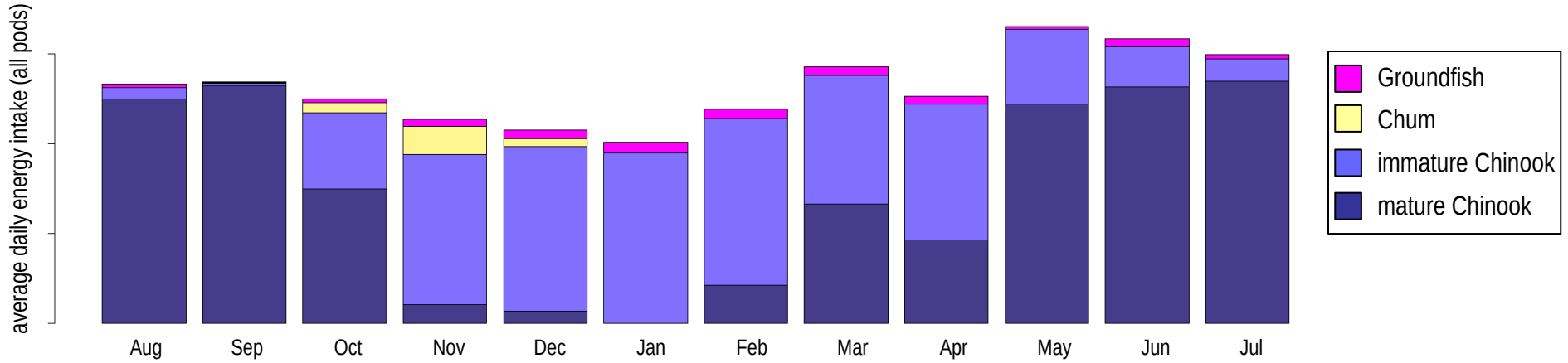
Recruitment model:

$$logit(F_{y,i}) = \beta_1 age_{i,y} + \beta_2 age_{i,y}^2 + \beta_3 age_{i,y}^3 + \beta_4 age_{i,y}^4 + \beta_5 E_{i,y-1}$$



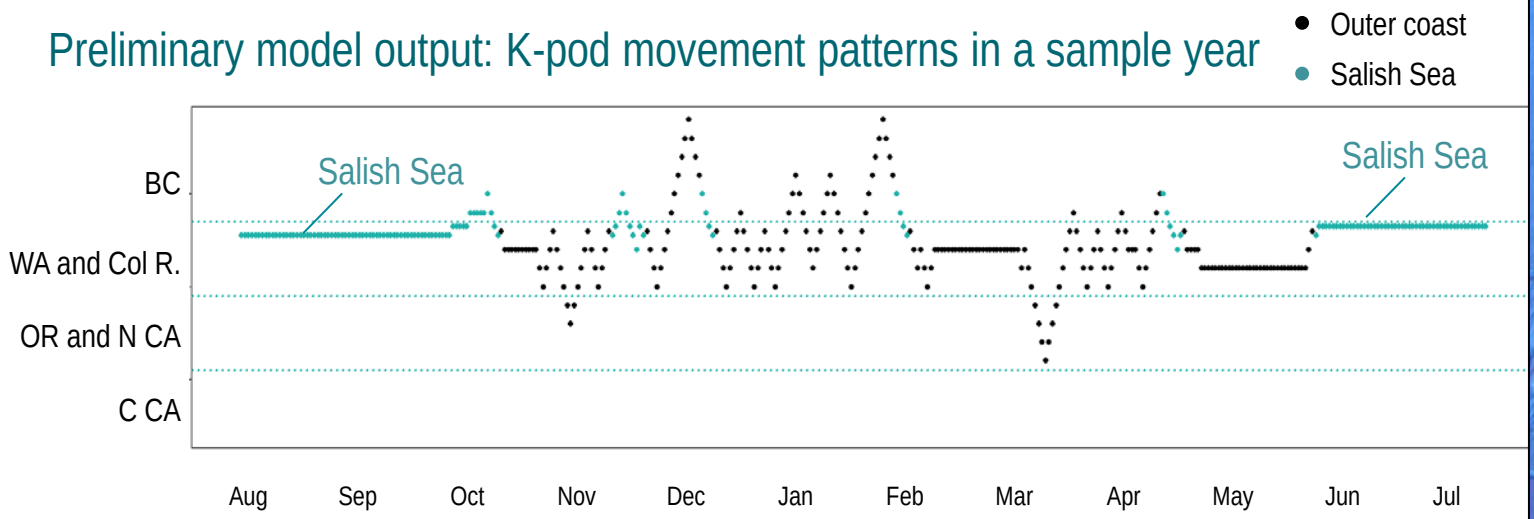
Source: Hanson 2012

Preliminary model output: seasonal diet



Performance metrics: diet

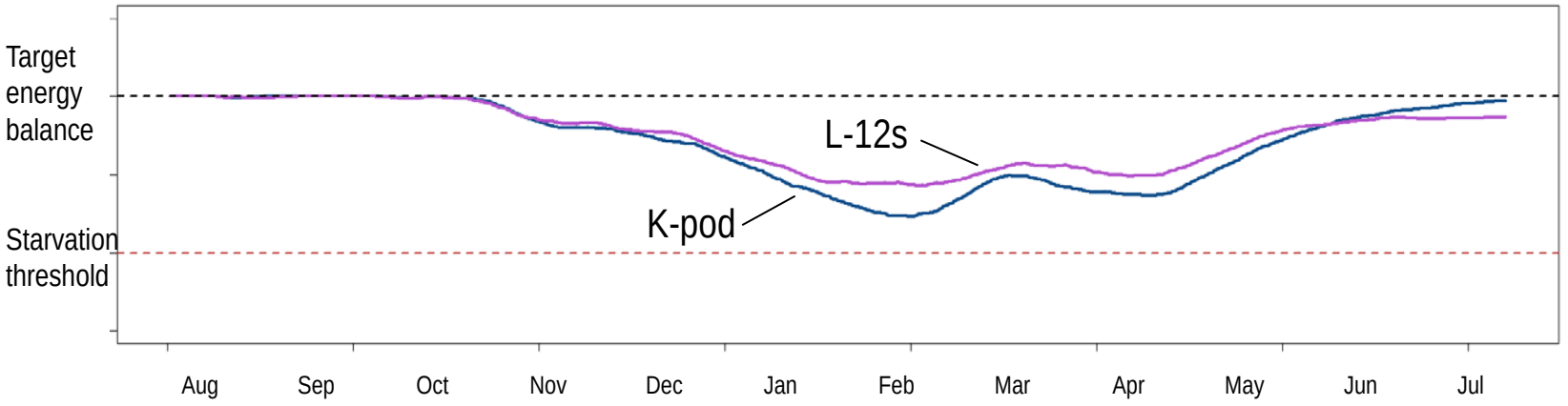
Preliminary model output: K-pod movement patterns in a sample year



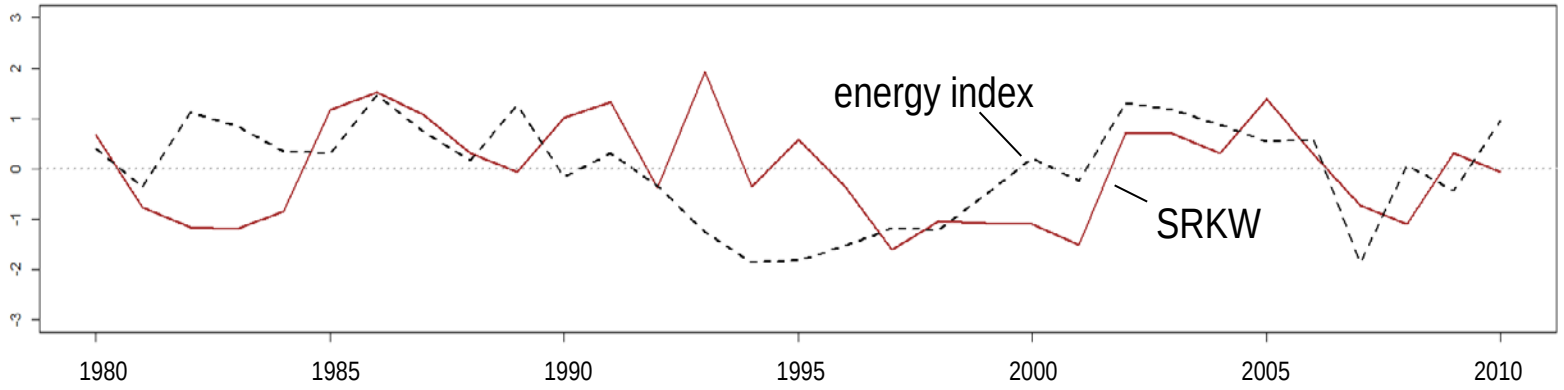
Source: NWFSC

Performance metrics: movement patterns

Preliminary model output: average seasonal changes in energy balance



Preliminary model output: standardized annual energy index vs change in SRKW population size



Performance metrics: energy balance, survival and recruitment

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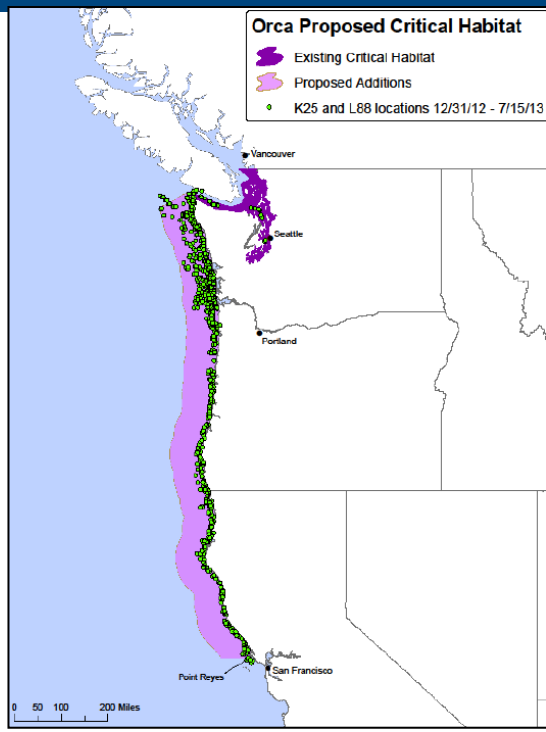
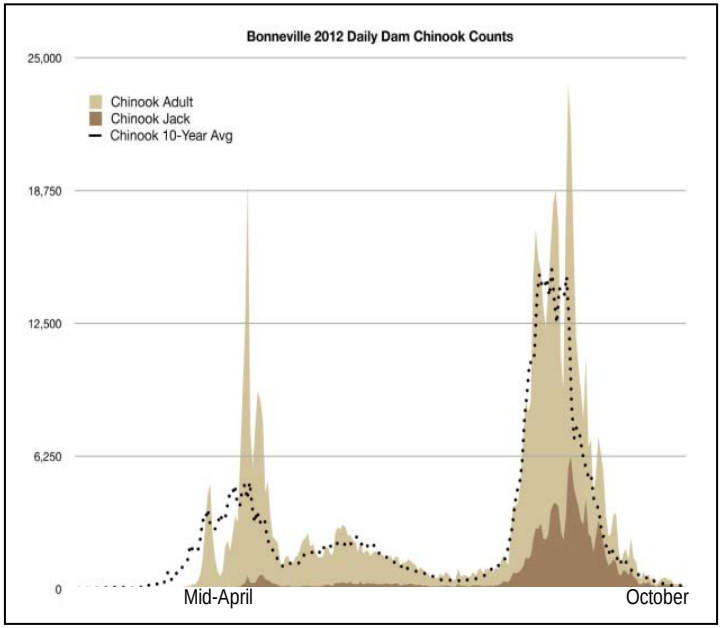
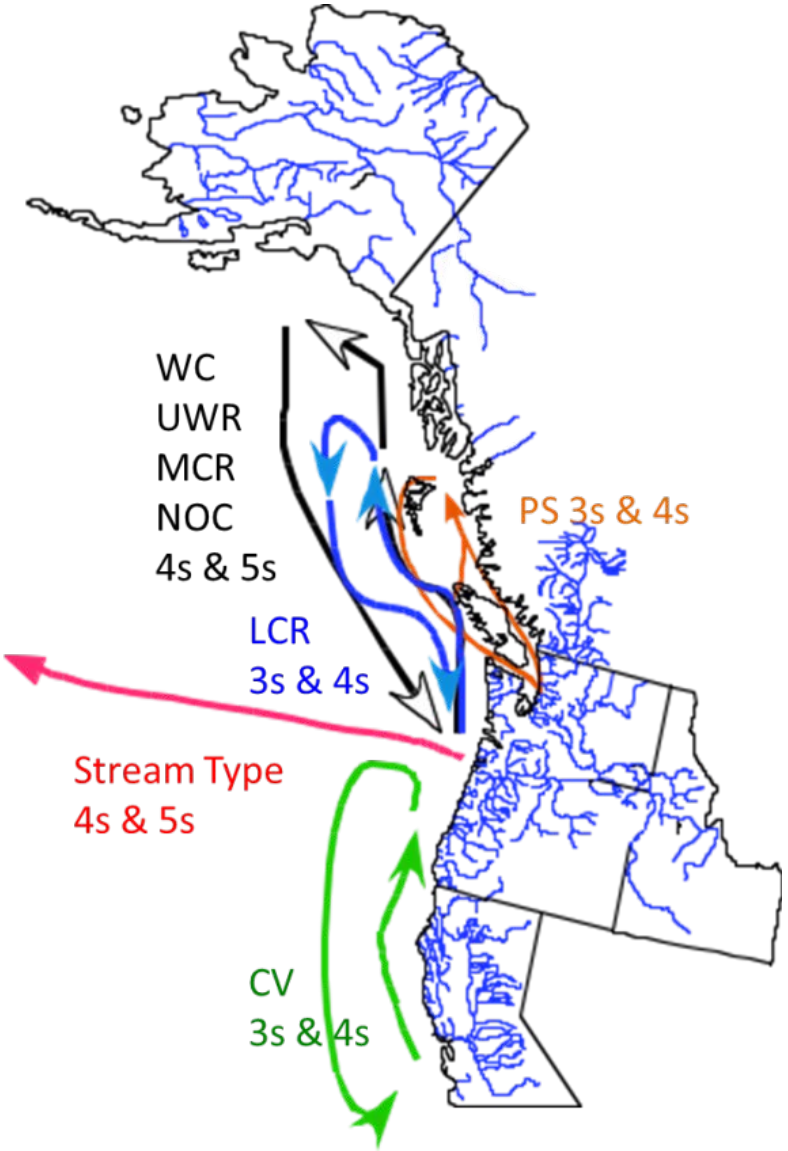




Source: CRITFC



Source: Myers 2012

Management Strategy Evaluation